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(56) Documents cited
GB 1495705
GB 1489967
GB 1392716
GB 1380381
GB 1340429
GB 1137030
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(54) Lining valves by hot isostatic pressing

(57) A method of forming a lining in the cavities of a body e.g. a valve casing 10 by application of powdered metal consolidated and bonded thereon by a hot isostatic pressing process. A space 36 lining the cavities in the body 10 is provided by tubular members 16, 24, one intersecting with the other, powdered metal fills the space 36, a vacuum is drawn on the space, the body is subjected to forming conditions and then the body cavities are machined to their final shape with such machining generally removing the tubular members. The cavities may be plated with nickel prior to lining. Stainless steel may be used as the lining material, also alloys of Ni, Cu, Co, Ta, Ti, and Ti carbides.

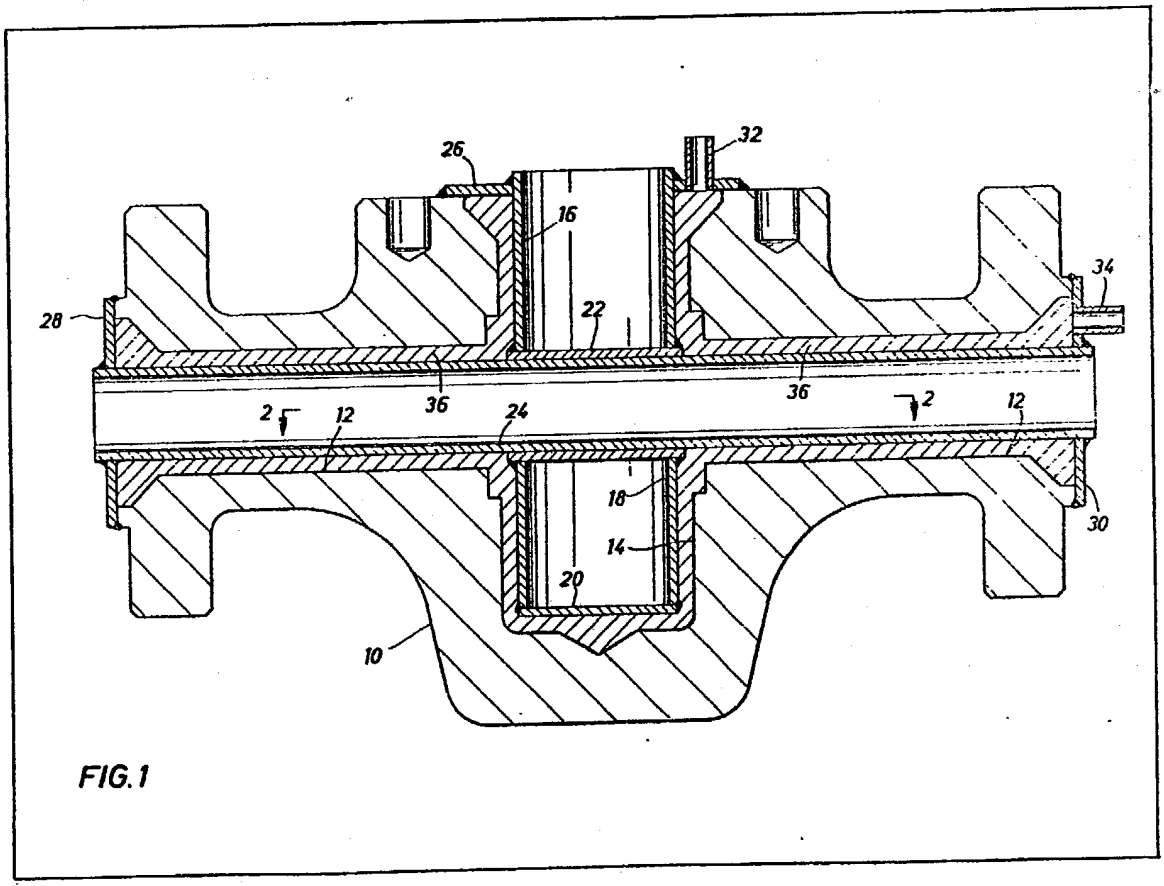

FIG. 1

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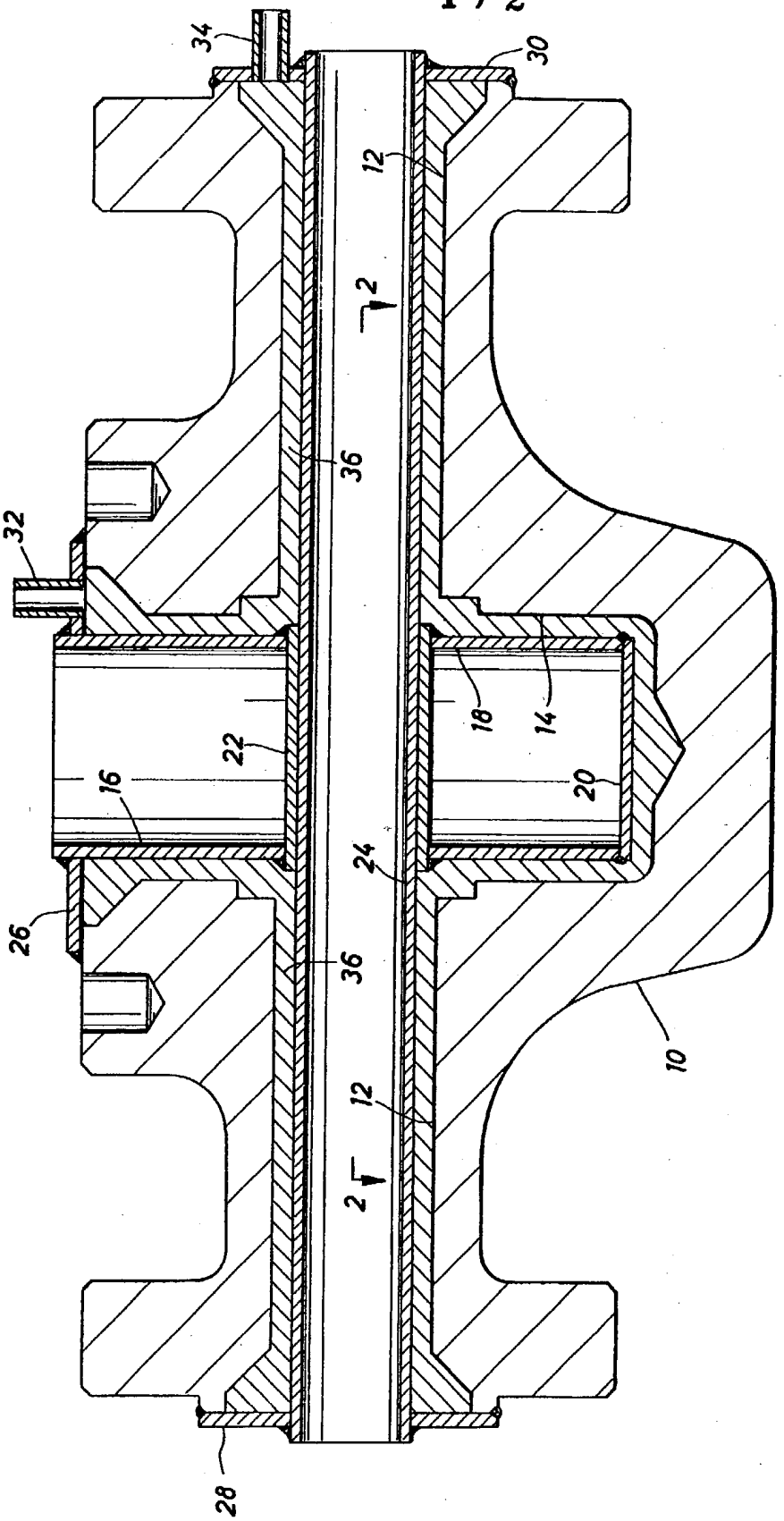
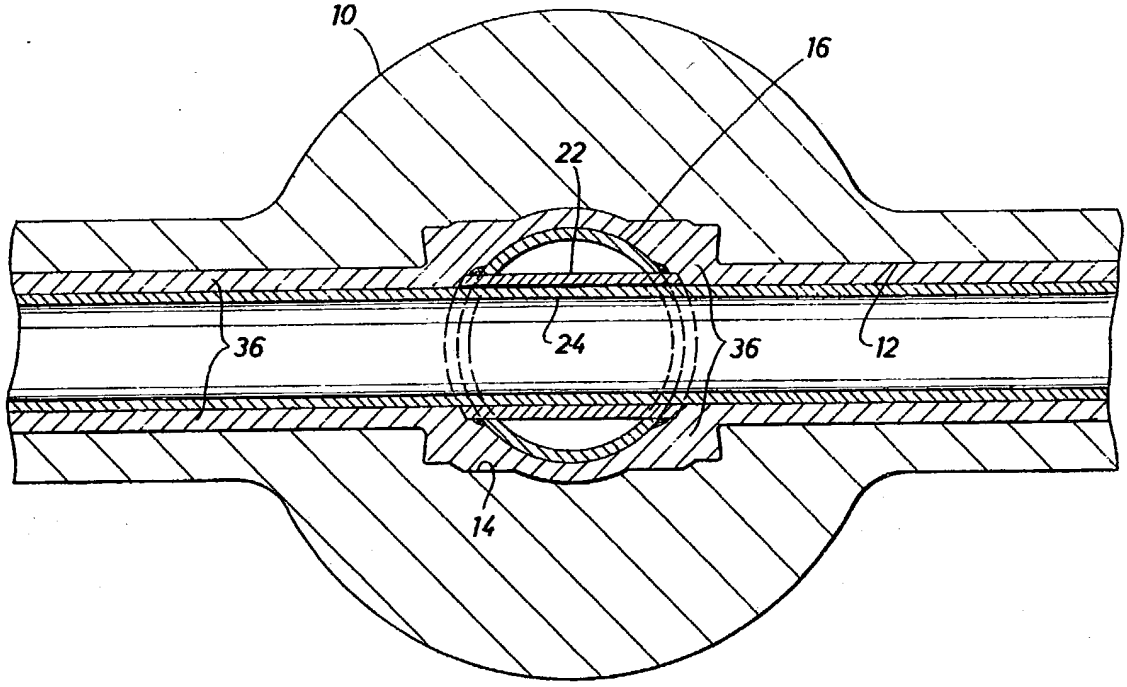


FIG.1

FIG. 2



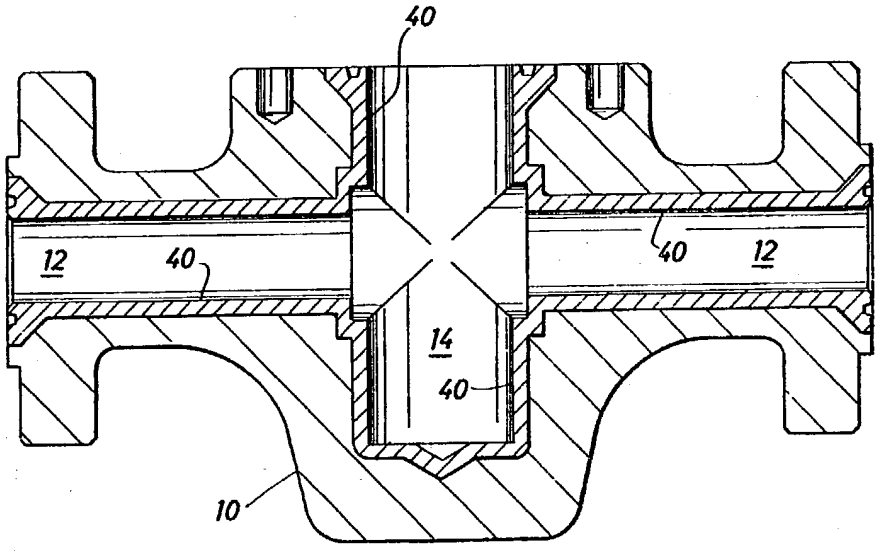


FIG. 3

SPECIFICATION

Method of producing a lined structure

There is a need for a high strength structure with corrosion resistant internal metal surfaces as, for example, a gate valve installed in a line containing corrosive fluids under high pressure. Such a valve could be made of AISI 4130 steel and have an interior (valve chamber and passages) lined with a 300 Series stainless steel.

Many attempts have been made to provide such structures. U.S. Patent Nos. 3,349,789 and 2,497,780 each provide valves with liners which must be secured and sealed in the flow passages but no provisions are made to line the valve chambers.

Products have been made by the hot isostatic pressure process by creating a space which is filled with powdered metal and surrounded with a flexible material which can maintain a seal under the forming temperature and pressure. The powdered metal when subjected to the heat and pressure becomes consolidated into the desired shape. The prior art methods have been devoted to forming solid structures or coating the exterior of a structure. Other examples of prior art may be found in U.S. Patent Nos. 3,631,583, 3,992,202 and 4,142,888, but such prior art does not disclose any method of using the hot isostatic pressing process to form a lining within cavities of a structure such as, for example, a valve body or a blowout preventer body.

The present invention relates to an improved hot isostatic pressing method of lining the cavities of a body. Hot isostatic pressing (HIP) is well known in the art and is described, for example, in Chapter 9 of the "Powder Metallurgy Equipment Manual" of the Powder Metallurgy Equipment Association, 2nd Ed. 1977. The method includes the steps of establishing a space within the body cavities bounded by the cavity walls and a yieldable mold filling the space with a powdered metal, drawing a vacuum on the space, and subjecting the body to forming temperature and pressure whereby a lining of the consolidated powdered metal is formed with the body cavity.

An object of the present invention is to provide an improved method of producing a body with lined cavities.

Another object is to provide an improved method of manufacturing a high strength alloy steel pressure containing structure having corrosion resistant material lining the interior surfaces of the structure.

A further object is to provide an improved method of lining cavities in a metal structure with metal consolidated by the hot isostatic pressing process.

Still another object is to provide an improved method of lining intersecting cavities within a metal structure.

These and other objects and advantages of the present invention are hereinafter set forth and explained with reference to the drawings wherein:

FIG. 1 is a cross-sectional view of a valve body illustrating the structure used to provide the space within the cavities of the structure.

FIG. 2 is a partial sectional view taken along line 2—2 in Fig. 1.

FIG. 3 is a cross-sectional view of the completed structure showing the finished structure with the consolidated metal lining after machining.

Valve body 10, shown in Fig. 1, is an alloy steel structure having cavities including flow passages 12 and valve chamber 14 which are to be provided with a corrosion resistant lining.

To prepare for the addition of metal powder, can 16, having thin tube 18, flat bottom 20 and thin sleeve 22 extending through the intermediate portion of tube 18 is inserted into valve chamber 14. Bottom 20 is sealed to the end of tube 18 as by welding and sleeve 22 is also sealed to tube 18 as by welding. Thin tube 24 is inserted through passages 12 and sleeve 22 as shown. Ring 26 is welded to the exterior of can 16 and to the exterior of body 10 as shown and rings 28 and 30 are welded around the ends of tube 24 and to the exterior of body 10. Fill tube 32 extends through ring 26 and fill tube 34 extends through ring 30. The structure of can 16, tube 24 and their sealing rings 26, 28 and 30 provides a space 36 within the walls of passages 12 and chamber 14. This structure functions as a pressure transmitting yieldable mold or thin metal sealed structure as hereinafter explained. It is important that all of the welds in the structure of can 16, sleeve 22 and tube 24 be air tight and remain so during the consolidation step to exclude air from the heated metal powder.

Space 36 within body cavities 12 and 14 is then filled through fill tubes 32 and 34 with a suitable metal powder, such as 316 stainless steel. It is recommended that body 10 be vibrated during filling of space 36 so that it is completely filled with the metal powder before proceeding to the next step. It is preferred that the material of can 16, tube 24 and rings 26, 28 and 30 be similar to the material used for the lining. Also, it is suggested that space be sufficiently large to provide a lining of consolidated metal which is sufficiently thick to allow for machining to the final shape without any depressions or holidays in the finished lining. When the same material is used for can 16 and tube 24, a portion of the finished lining may be the material of can 16 and tube 24.

When space 36 is completely filled, a vacuum is drawn thereon by connection of suitable means such as a vacuum pump (not shown) to either or both of fill tubes 32 and 34. Sufficient vacuum should be drawn so that the amount of gases present in space 36 will not interfere with the formation of a suitable consolidated metal lining. When the desired vacuum is reached fill tubes 32 and 34 are closed and sealed. If desired, suitable valves (not shown) may be secured thereon so that they may be closed when the vacuum drawing step is finished. Such valves are recommended to be leak proof when subjected to forming conditions.

Thereafter, body 10 is placed in an autoclave (not shown) or other suitable device wherein it is subjected to forming temperature (2100°F approximately) and pressure (15,000 psi approximately). The body 10 is retained in such forming condition for several hours and then it is allowed to cool.

During exposure to forming conditions in the autoclave, can 16 and tube 24, being yieldable, are expanded to compress the powdered metal against the walls of passages 12 and chamber 14. The heat and pressure thus cause the metal to be consolidated into a solid lining within the body which is completely bonded to the walls of passages 12 and chamber 14. If can 16 and tube 24 are made of the same material as the lining, they will be integral with the lining and may form a part of the final product.

The cooled body 10 is heat treated as required to obtain the desired mechanical properties and then machined to the shape shown in Fig. 3. It then has a uniform smooth corrosion resistant lining 40 on the walls of passages 12 and chamber 14. If can 16 and tube 24 are made of a different material from the lining, they will preferably be entirely removed during the machining step.

It is suggested that the walls to be lined by the method of the present invention be nickel plated as preparation for the forming of a lining by the method of the present invention. It is believed that the nickel plating prevents oxidation, helps obtain bond continuity and prevents the chrome in the metal powder from migrating into the alloy and forming an undesired martensitic structure.

It is contemplated that the method of the present invention may be used to provide linings of nickel, nickel alloys, tantalum, Hastelloy (Registered Trade Mark) alloys, copper, copper alloys, cobalt base alloys, stainless steels and titanium alloys and carbides bonded to a body of various grades of alloy steel, carbon steel or stainless steels.

The method of the present invention provides a lining on the walls of intersecting bores or cavities in a thick-walled pressure vessel by using the pressure vessel as the base metal to accept the hot isostatic pressed metal powder. The structure shown and described is an alloy steel valve body lined with stainless steel. The method may be used to line the bore and guideways of a blowout preventer body by using two stainless steel tubes as the mold around the space in which the metal powder is placed in place of the tube and can described.

The formation conditions (temperature, pressure, time and degree of vacuum) are well known and should be adjusted to the particular materials being used.

CLAIMS

1. The method of lining a body having a plurality of cavities including the steps of securing and sealing a thin metal sealed structure within the body cavities in spaced relation to the walls of the cavities, filling the space between the walls of the cavities and the sealed structure with metal powder, evacuating gas from the said space, subjecting the body with the sealed structure and metal powder therein to a temperature of approximately 2,100°F and a pressure of approximately 15,000 psi for a period of approximately two hours, to consolidate the metal powder into a dense uniform lining in the cavities, cooling the lined body, and machining the lined cavities to the desired dimensions.

2. The method according to claim 1 including the steps of nickel plating said body cavities prior to said securing step.

3. The method according to claim 1 wherein said machining step removes the thin metal sealed structure from the interior of the lined cavities.

4. The method according to claim 1 wherein said cavities include two intersecting cavities.

5. The method of lining a metal body having a cavity including the steps of positioning a pressure transmitting metal mold within and spaced from the walls of the cavity in the body, filling the space between the mold and the walls of the cavity with metal powder, drawing a vacuum on said space filled with metal powder, and subjecting the body and mold to sufficient temperature and pressure for a sufficiently long period to consolidate the metal powder into a dense uniform metal lining of the cavity.

6. The method of applying a corrosion resistant coating to an internal surface of a high strength pressure vessel comprising securing and sealing a yieldable mold in spaced relationship to the surface to be coated, filling the space between the surface and the mold with metal powder, drawing a vacuum in the space, and subjecting the mold, metal powder and structure to elevated temperature and pressure sufficient to consolidate the metal powder into a dense uniform coating on the surface.

7. The method according to claim 6 including the step of nickel plating said surface prior to the securing step.

8. The method according to claim 6 wherein said vessel is a high strength alloy steel and said coating is a stainless steel.

9. The method according to claim 6 including the step of machining off the mold and excess coating.

10. The method according to claim 8 wherein said mold is stainless steel and including the step of machining said mold and coating to provide the desired surface.

11. The method of producing a lined valve structure including the steps of machining the chamber and flow passages over-sized in a valve body, nickel plating the machined walls of the chamber, and the flow passages, inserting a stainless steel can into the chamber, said can being sized to be spaced from the machined walls of the chamber, said can having a sleeve extending therethrough and welded therein, inserting a stainless steel tube into the body passages and through the sleeve, securing end

closure rings around the open ends of said can and said tube, securing said end closure rings to the exterior of said valve body to assure that said can and said sleeve are spaced uniformly from the machined walls of the body, one of said closure rings having a fill tube extending therethrough, flowing a stainless steel metal powder through said fill tube into the space in said cavity and passages surrounding said can and said tube, vibrating said valve body to assure complete filling of the space with the metal powder, withdrawing gas from said space to reduce the pressure therein, closing and sealing the fill tube, heating the body, can, sleeve and metal powder under forming pressure to forming temperature, maintaining the temperature and pressure in the autoclave for a sufficient time to cause the metal powder to be consolidated into a lining, allowing the lined body to cool, and machining the lined chamber and passages to their desired dimensions.

12. A lined valve body comprising an alloy steel body having a valve chamber and flow passages, and a consolidated powdered metal lining the walls of the valve chamber and the flow passages.

13. A lined structure comprising a body having a plurality of cavities therein, and a consolidated powdered metal lining the walls of the cavities.

14. A lined structure according to claim 13 wherein the cavities in said body are intersecting cavities.

15. A method of lining a body substantially as hereinbefore described.

16. A lined structure substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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